N91-21373

# RADIOGRAPHIC INSTRUMENTATION FOR DPM EXPERIMENTS

A.L. Fripp and W.J. Debnam
Langley Research Center, Hampton, VA

R.T. Simchick
Lockheed Corporation, Hampton, VA
and

P.G. Barber
Longwood College, Farmville, VA

Radiography has been successfully used to monitor both the shape and position of the melt-solid interface in Bridgman growth and has been used, by others, to observe fluid flow. The image recording medium is either film or image enhanced real time VCR recording.

The presented paper discussed the new developments in x-ray radiography that may be applicable to containerless experimentation. The two features discussed were the use of radiography to determine the position and shape of the solid-liquid interface and, with the aid of appropriate markers, the flow patterns in either the surface or bulk of the liquid state. In addition, both surface energy and fluid viscosity measurements can be made with the aid of the described radiographic system.

The experimental techniques presented were developed under MSAD-ATD support and are part of an ongoing research effort at Langley Research Center.

CONTAINERLESS EXPERIMENTATION
IN
MICROGRAVITY WORKSHOP

17-19 JANUARY, 1990

# RADIOGRAPHIC INSTRUMENTATION FOR DPM EXPERIMENTS

Archie Fripp and W.J. Debnam
Langley Research Center, Hampton, Va.

R.T. Simchick
Lockheed Corporation, Hampton, Va.

and
P.G. Barber
Longwood College, Farmville, Va.

# OBJECTIVE OF TALK

TO INTRODUCE A MEASUREMENT TECHNIQUE DEVELOPED FOR BRIDGMAN CRYSTAL GROWTH WHICH MAY, IF PROPERLY DEVELOPED, BE USEFUL TO THE CONTAINERLESS PROCESSING EXPERIMENTS FOR THE MEASUREMENT OF THE LIQUID-SOLID INTERFACE AND BOTH SURFACE AND BULK FLUID FLOW.

* RADIOGRAPHIC INSTRUMENTATION IN BRIDGMAN GROWTH

I. INTERFACE MEASUREMENTS
- IMPORTANCE OF INTERFACE
- INSTRUMENTATION
- FILM RESULTS
- REAL TIME MEASUREMENTS

II. FLUID FLOW
- MARKER DEVELOPMENT
- BUBBLE MOVEMENT

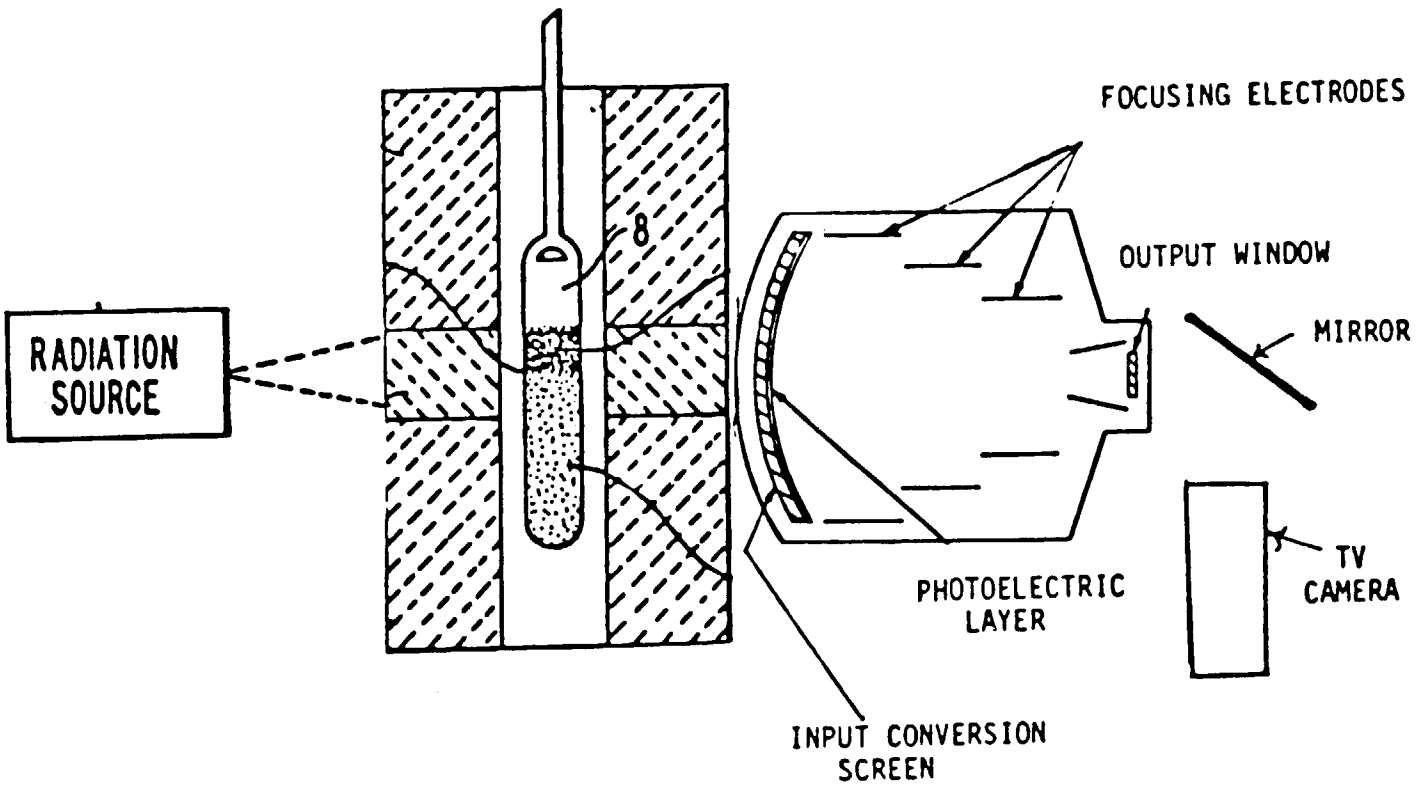
* APPLICATIONS TO CONTAINERLESS PROCESSING

SURFACE AND BULK FLOW MEASUREMENTS

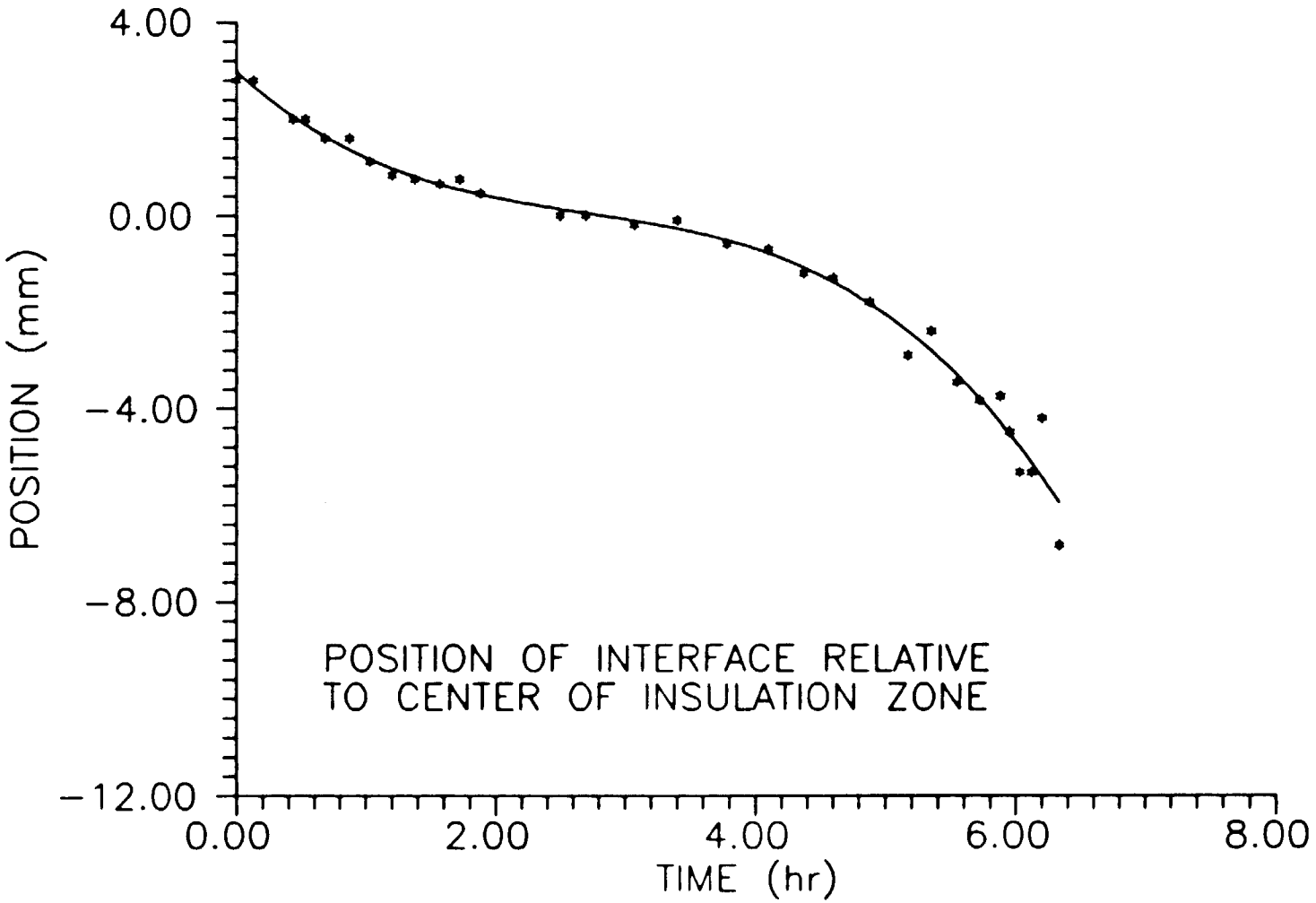
* APPLICATIONS TO OTHER MEASUREMENTS

VISCOSITY AND SURFACE ENERGY

* CONCLUSIONS




REAL TIME RADIOGRAPHY


4.00
0.00
-4.00
-8.00
-12.00
POSITION (mm)
POSITION OF INTERFACE RELATIVE
TO CENTER OF INSULATION ZONE
0.00
2.00
4.00
6.00
8.00
TIME (hr)

# REQUIREMENTS FOR FLUID FLOW MARKERS

WET BY FLUID

IMPERVIOUS TO FLUID

MATCHING FLUID DENSITY

LARGE X-RAY DENSITY

SMALL SIZE

NON-NUCLEATING SURFACE

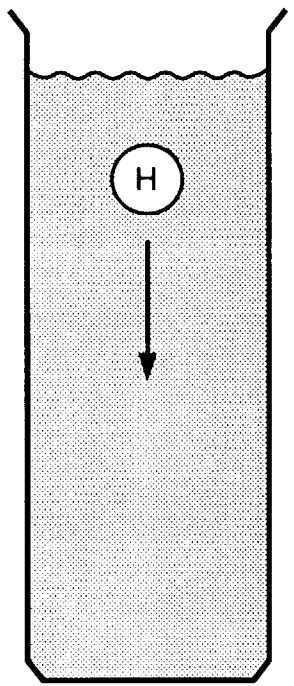
# VISCOSITY MEASUREMENTS

STOKES LAW, $V_t$

$V_t = gD(\rho_L - \rho_S) / 18\mu$

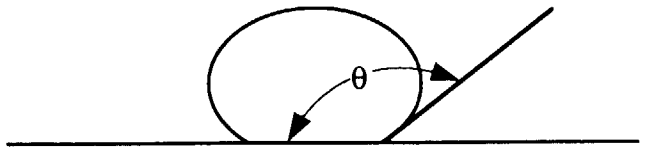
DROP SPHERE OF KNOWN DIAMETER & DENSITY

MEASURE DROP TIME

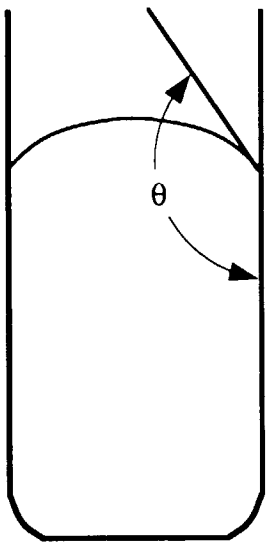


# SURFACE TENSION MEASUREMENTS

YOUNG & DUPRE EQUATION




$$\cos\theta = \frac{\sigma_{SV} - \sigma_{SL}}{\sigma_{LV}}$$



# SUMMARY

TECHNIQUE PROVEN USEFUL IN BRIDGMAN GROWTH INTERFACE MEASUREMENTS

FLUID FLOW AS YET UNPROVEN

CAN IT BE USEFUL FOR MCPF TYPE EXPERIMENTS?

APPLICATIONS TO OTHER THERMOPHYSICAL MEASUREMENTS?